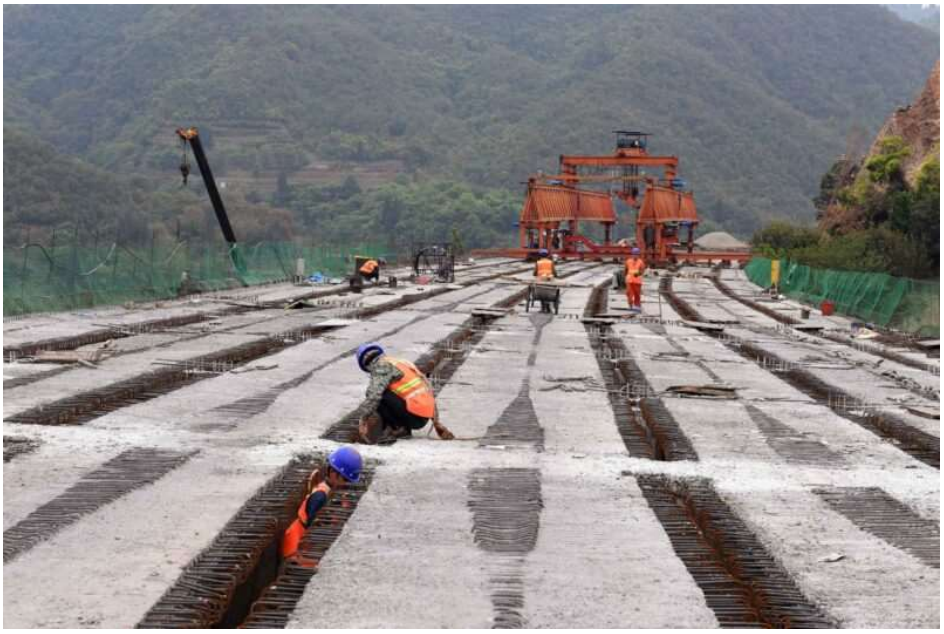

The construction site of an expressway in southwest China's Yunnan province. Climate change plus the pressures of deforestation and infrastructure development have reduced animal habitat and turned Yunnan into a global hot spot for emerging infectious disease. (Xinhua/Yang Zongyou via Getty Images)

CORONAVIRUS

How Climate Change Is Contributing to Skyrocketing Rates of Infectious Disease

A catastrophic loss in biodiversity, reckless destruction of wildland and warming temperatures have allowed disease to explode. Ignoring the connection between climate change and pandemics would be "dangerous delusion," one scientist said.

by Abrahm Lustgarten, May 7, 5 a.m. EDT

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The scientists who study how diseases emerge in a changing environment knew this moment was coming. Climate change is making outbreaks of disease more common and more dangerous.

Over the past few decades, the number of emerging infectious diseases that spread to people — especially coronaviruses and other respiratory illnesses believed to have come from bats and birds — has skyrocketed. A new emerging disease surfaces five times a year. One study estimates that more than 3,200 strains of coronaviruses already exist among bats, awaiting an opportunity to jump to people.

The diseases may have always been there, buried deep in wild and remote places out of reach of people. But until now, the planet's natural defense systems were better at fighting them off.

Today, climate warming is demolishing those defense systems, driving a catastrophic loss in biodiversity that, when coupled with reckless deforestation and aggressive conversion of wildland for economic development, pushes farms and people closer to the wild and opens the gates for the spread of disease.

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Note: If you develop emergency warning signs for COVID-19, such as difficulty breathing or bluish lips, get medical attention immediately. The CDC has more information on what to do if you are sick.

Aaron Bernstein, the interim director for the C-Change Center for Climate, Health and the Global Environment at Harvard University's T.H. Chan School of Public Health, said that ignoring how climate and rapid land development were putting disease-carrying animals in a squeeze was akin to playing Russian roulette.

"Nature is trying to tell us something," Bernstein said.

Scientists have not suggested that climate played any direct role in causing the current COVID-19 outbreak. Though the virus is believed to have originated with the horseshoe bat, part of a genus that's been roaming the forests of the planet for 40 million years and thrives in the remote jungles of south China, even that remains uncertain.

Scientists have, however, been studying the coronaviruses of southern China for years and warning that swift climate and environmental change there — in both loss of biodiversity and encroachment by civilization — was going to help new viruses jump to people.

There are three ways climate influences emerging diseases. Roughly 60% of new pathogens come from animals — including those pressured by diversity loss — and roughly one-third of those can be directly attributed to changes in human land use, meaning deforestation, the introduction of farming, development or resource extraction in otherwise natural settings. Vector-borne diseases — those carried by insects like mosquitoes and ticks and transferred in the blood of infected people — are also on the rise as warming weather and erratic precipitation vastly expand the geographic regions vulnerable to contagion. Climate is even bringing old viruses back from the dead, thawing zombie contagions like the anthrax released from a frozen reindeer in 2016, which can come down from the arctic and haunt us from the past.

Thus the COVID-19 pandemic, even as it unfolds in the form of an urgent crisis, is offering a larger lesson. It is demonstrating in real time the enormous and undeniable power that nature has over civilization and even over its politics. That alone may make the pandemic prologue for more far-reaching and disruptive changes to come. But it also makes clear that climate policy today is indivisible from efforts to prevent new

infectious outbreaks, or, as Bernstein put it, the notion that climate and health and environmental policy might not be related is "a dangerous delusion."

The warming of the climate is one of the principal drivers of the greatest — and fastest — loss of species diversity in the history of the planet, as shifting climate patterns force species to change habitats, push them into new regions or threaten their food and water supplies. What's known as biodiversity is critical because the natural variety of plants and animals lends each species greater resiliency against threat and together offers a delicately balanced safety net for natural systems. As diversity wanes, the balance is upset, and remaining species are both more vulnerable to human influences and, according to a landmark 2010 study in the journal Nature, more likely to pass along powerful pathogens.

The casualties are amplified by civilization's relentless push into forests and wild areas on the hunt for timber, cropland and other natural resources. Epidemiologists tracking the root of disease in South Asia have learned that even incremental and seemingly manageable injuries to local environments — say, the construction of a livestock farm adjacent to stressed natural forest — can add up to outsized consequences.

Around the world, according to the World Resources Institute, only 15% of the planet's forests remain intact. The rest have been cut down, degraded or fragmented to the point that they disrupt the natural ecosystems that depend on them. As the forests die, and grasslands and wetlands are also destroyed, biodiversity sharply decreases further. The United Nations warns that the number of species on the planet has already dropped by 20% and that more than a million animal and plant species now face extinction.

Losing species has, in certain cases, translated directly to a rise in infectious disease.

Peatland fires in Indonesia in 2018 used to clear forests for palm oil plantations. Deforestation is one of the largest drivers of the emergence of new infectious diseases. (Wahyudi/AFP via Getty Image)

Americans have been experiencing this phenomenon directly in recent years as migratory birds have become less diverse and the threat posed by West Nile encephalitis has spread. It turns out that the birds that host the disease happen to also be the tough ones that prevail amid a thinned population. Those survivors have supported higher infection rates in mosquitoes and more spread to people.

Similarly, a study published last month in the journal Proceedings of the Royal Society B found that as larger mammals suffer declines at the hands of hunters or loggers or shifting climate patterns, smaller species, including bats, rats and other rodents, are thriving, either because they are more resilient to the degraded environment or they are able to live better among people.

It is these small animals, the ones that manage to find food in garbage cans or build nests in the eaves of buildings, that are proving most adaptable to human interference and also happen to spread disease. Rodents alone accounted for more than 60% of all the diseases transmitted from animals to people, the researchers found.

Warmer temperatures and higher rainfall associated with climate change — coupled with the loss of predators — are bound to make the rodent problem worse, with calamitous implications. In 1999, for example, parts of Panama saw three times as much rainfall as usual. The rat population exploded, researchers found. And so did the viruses rats carry, along with the chances those viruses would jump to people. That same year, a fatal lung disease transmitted through the saliva, feces and urine of rats and mice called hantavirus pulmonary syndrome emerged in Panama for the first time, according to a report in the journal Emerging Infectious Diseases.

As much as weather changes can drive changes in species, so does altering the landscape for new farms and new cities. In fact, researchers attribute a full 30% of emerging contagion to what they call "land use change." Nothing drives land use shifts more than conversion for farmland and feedstock — a result of the push to feed the planet's 7.8 billion people. As the global population surges to 10 billion over the next 35 years, and the capacity to farm food is stressed further again by the warming climate, the demand for land will only get more intense. Already, more than one-third of the planet's land surface, and three-quarters of all of its fresh water, go toward the cultivation of crops and raising of livestock. These are the places where infectious diseases spread most often.

Take, for example, the 1999 Nipah outbreak in Malaysia — the true-life subject matter adapted for the film "Contagion." Rapid clearcutting of the forests there to make way for palm plantations drove fruit bats to the edge of the trees. (Separate research also suggests that climate changes are shifting fruit bats' food supply.) They found places to roost, as it happens, alongside a hog farm. As the bats gorged themselves on fruit, they dropped pieces of food from the branches, along with their urine, into the pigsties, where at least one pig is believed to have eaten some. When the pig was slaughtered and brought to market, an outbreak is believed to have been spread by the man who handled the meat. More than 100 people died.

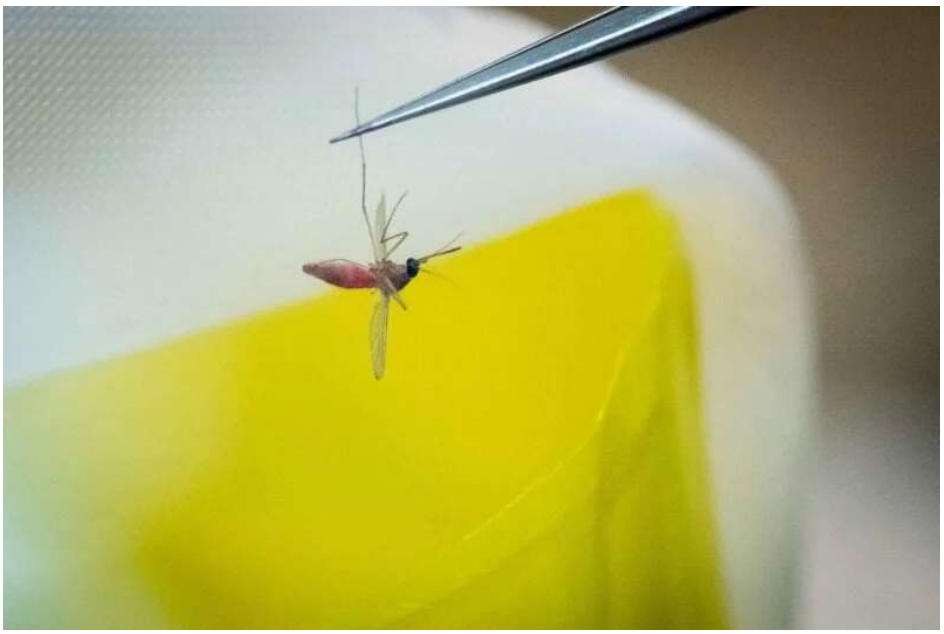
The U.S. Centers for Disease Control and Prevention says that fully three-quarters of all new viruses have emerged from animals. Even the 2014 Ebola outbreak in West Africa is believed to have begun when a boy dug into a tree stump that happened to be the roost of bats carrying the virus.

As Christine Johnson, the associate director of the One Health Institute, an interdisciplinary epidemiological program at the University of California, Davis, puts it, global health policymakers have a responsibility to understand how climate, habitat and land use changes lead to disease. Almost every major epidemic we know of over the past couple of decades — SARS, COVID-19, Ebola and Nipah virus — jumped to people from wildlife enduring extreme climate and habitat strain, and still, "we're naive to them," she said. "That puts us in a dangerous place."

Once new diseases are let loose in our environment, changing temperatures and precipitation are also changing how those diseases spread — and not for the better. Warming climates increase the range within which a disease can find a home, especially those transmitted by "vectors," mosquitoes and ticks that carry a pathogen from its primary host to its new victim.

A 2008 study in the journal Nature found nearly one-third of emerging infectious diseases over the past 10 years were vector-borne, and that the jumps matched unusual changes in the climate. Especially in cases where insects like infection-bearing mosquitoes are chasing warmer

temperatures, the study said, "climate change may drive the emergence of diseases."



A mosquito in a laboratory of the Friedrich-Loeffler Institute in Germany. Scientists say at least 500 million more people, including 55 million more Americans, will be susceptible to mosquito-borne diseases as the climate warms. (Steffen Kugler/Getty Images)

Ticks and mosquitoes now thrive in places they'd never ventured before. As tropical species move northward, they are bringing dangerous pathogens with them. The Zika virus or Chikungunya, a mosquito-spread virus that manifests in intense joint pain, were once unseen in the United States, but both were transmitted locally, not brought home by travelers, in southern Texas and Florida in recent years.

Soon, they'll be spreading further northward. According to a 2019 study in the journal PLOS Neglected Tropical Diseases, by 2050, disease-carrying mosquitoes will ultimately reach 500 million more people than they do today, including some 55 million more Americans. In 2013, dengue fever — an affliction affecting nearly 400 million people a year, but normally associated with the poorest regions of Africa — was transmitted locally in New York for the first time.

"The long-term risk from dengue may be much higher than COVID," said Scott Weaver, the director of the Institute for Human Infections and Immunity at the University of Texas Medical Branch in Galveston. "It's a disease of poor countries, so it doesn't get the attention it deserves."

The chain of events that ultimately leads to a pandemic can be long and subtle, steered by shifts in the ecosystem. The 1999 West Nile outbreak in the U.S., for example, came after climate-driven droughts dried up streams and rivers, leaving pools of stagnant water where mosquitoes bred unhindered. It turns out the loss of water also killed off their predators — dragonflies and frogs that depend on large watering holes were gone.

Coronaviruses like COVID-19 aren't likely to be carried by insects — they don't leave enough infected virus cells in the blood. But one in five other

viruses transmitted from animals to people are vector-borne, said U.C. Davis' Johnson, meaning it's only a matter of time before other exotic animal-driven pathogens are driven from the forests of the global tropics to the United States or Canada or Europe because of the warming climate. "Climate is going to shift vulnerability to that," Johnson said, "and I think some of these regions are not prepared."

The changing climate won't just affect how the diseases move about the planet, it will also shape how easily we get sick. According to a 2013 study in the journal PLOS Currents Influenza, warm winters were predictors of the most severe flu seasons in the following year. The brief respite in year one, it turns out, relaxed people's natural defenses and reduced "herd immunity," setting conditions for the virus to rage back with a vengeance.

Even harsh swings from hot to cold, or sudden storms — exactly the kinds of climate-induced patterns we're already seeing — make people more likely to get sick. A study in the journal Environmental Research Letters linked the brutal 2017-18 flu season — which killed 79,000 people — to erratic temperature swings and extreme weather that winter, the same period in which a spate of floods and hurricanes devastated much of the country. If the climate crisis continues on its current trajectory, the authors wrote, respiratory infections like the flu will sharply increase. The chance of a flu epidemic in America's most populated cities will increase by as much as 50% this century, and flu-related deaths in Europe could also jump by 50%.

"We're on a very dangerous path right now," said the University of Texas' Weaver. Slow action on climate has made dramatic warming and large-scale environmental changes inevitable, he said, "and I think that increases in disease are going to come along with it."

Twelve months before the first COVID-19 case was diagnosed, a group of epidemiologists working with a U.S. Agency for International Development project called PREDICT, or Pandemic Influenza and other Emerging Threats, was deep in the remote leafy jungle of southern China's Yunnan province hunting for what it believed to be one of the greatest dangers to civilization: a wellspring of emerging viruses.

A decade of study there had identified a pattern of obscure illnesses affecting remote villagers who used bat guano as fertilizer and sometimes for medicine. Scientists traced dozens of unnamed, emerging viruses to caves inhabited by horseshoe bats. Any one of them might have triggered a global pandemic killing a million people. But luck — and mostly luck alone — had so far kept the viruses from leaping out of those remote communities and into the mainstream population.

The luck is likely to run out, as Yunnan is undergoing enormous change. Quaint subsistence farm plots were overtaken by hastily erected apartment towers and high-speed rail lines, as the province endured dizzying development fueled by decades of Chinese economic expansion.

Cities' footprints swelled, pushing back the forests. More people moved into rural places and the wildlife trade, common to such frontier regions, thrived. With every new person and every felled tree, the bats' habitat shrank, putting the viruses they carried on a collision course with humanity. By late 2018, epidemiologists there were bracing for what they call "spillover," or the failure to keep a virus locally contained as it jumped from the bats and villages of Yunnan into the wider world.

In late 2018, the Trump administration, as part of a sweeping effort to bring U.S. programs in China to a halt, abruptly shut down the research — and its efforts to intercept the spread of a new novel coronavirus along with it. "We got a cease and desist," said Dennis Carroll, who founded the PREDICT program and has been instrumental in global work to address the risks from emerging viruses. By late 2019, USAID had cut the program's global funding.

USAID did not respond to a detailed list of questions from ProPublica.

The loss is immense. The researchers believed they were on the cusp of a breakthrough, racing to sequence the genes of the coronaviruses they'd extracted from the horseshoe bat and to begin work on vaccines. They'd campaigned for years for policymakers to fully consider what they'd learned about how land development and climate changes were driving the spread of disease, and they thought their research could literally provide governments a map to the hot spots most likely to spawn the next pandemic. They also hoped the genetic material they'd collected could lead to a vaccine not just for one lethal variation of COVID, but perhaps — like a missile defense shield for the biosphere — to address a whole family of viruses at once. (In fact, the gene work they were able to complete was used to test the efficacy of remdesivir, an experimental drug that early clinical trial data shows can help COVID-19 patients.)

Carroll said knowledge of the virus genomes had the potential "to totally transform how we think about future biomedical interventions before there's an emergence." His goal was to not just react to a pandemic, but to change the very definition of preparedness.

If PREDICT's efforts in China had the remote potential to fend off the current COVID pandemic, though, it also offered an opportunity to study how climate and land development were driving disease.

But there has been little appetite for that inquiry among policymakers. PREDICT's staff and advisers have pushed the U.S. government to consider how welding public health policy with environmental and climate science could help stem the spread of contagions. Climate change was featured in presentations that PREDICT staff made to Congress, according to U.C. Davis' Johnson, who is now also the director of PREDICT, which received a temporary funding extension this spring. And until 2016, leadership of New York-based EcoHealth Alliance, the research group working under PREDICT funding in Yunnan, was invited several times to the White House to advise on global health policy.

Since Donald Trump was elected, the group hasn't been invited back.

"It's falling on deaf ears," said Peter Daszak, EcoHealth Alliance's president.

A White House spokesperson did not respond to an emailed request for comment.

What Daszak really wants — in addition to restored funding to continue his work — is the public and leaders to understand that it's human behavior driving the rise in disease, just as it drives the climate crisis. In China's forests, he looks past the destruction of trees and asks why they are being cut in the first place, and who is paying the cost. Metals for iPhones and palm oil for processed foods are among the products that come straight out of South Asian and African emerging disease hot spots.

"We turn a blind eye to the fact that our behavior is driving this," he said. "We get cheap goods through Walmart, and then we pay for it forever through the rise in pandemics. It's upside down."

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